STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

MICHAEL F. EASLEY
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SECRETARY

October 11, 2004

I-40 Slide Project
C201230
Haywood County

To Whom It May Concern:

The Roadway Design Unit, Structure Design Unit, Hydraulics Unit, Geotechnical Engineering Unit has prepared the following PRELIMINARY package dated October 11, 2004 for use by the Contractors and geotechnical subcontractors for developing their design concepts and bids. The final plans and contract documents will be provided at a later date.

Enclosed in this second package are the following DRAFT items:

1) **Timeline**

2) **Geotechnical - General Scope of Work**

3) **Project Special Provisions**
   a) Permanent Anchor Tieback Retaining wall
   b) Toe Scour Protection
   c) Tensioned rock bolts

4) **Roadway - Plans and cross-sections**

5) **Structure - Tieback wall plans and toe scour protection detail**

6) **Hydraulic Unit plan sheets**

7) **Geotechnical Subsurface Inventory**

If there are any questions, please call me at (919) 250-4124.

R.E. Garris, P.E.
Contract Officer

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RALEIGH NC

I-40 Slide Project
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PERMANENT ANCHOR TIEBACK RETAINING WALL:

1.0 General:

The work under this section consists of design, plan preparation, furnishing materials, and construction of proposed Permanent Tieback Retaining Wall No. 1 from Station 17+00.00 -L- to Station 22+25.00 -L-, and proposed Permanent Tieback Retaining Wall No. 2 from Station 33+00.00 -L- to Station 35+00.00 -L- in accordance with the plans, these specifications and in reasonably close conformity with the lines, grades, and dimensions shown on the plans.

A permanent anchor tieback anchor retaining wall consists of soldier piles and timber lagging supported by post-tensioned ground anchors with permanent precast concrete facing.

Submit 8 copies of plans and calculations to the Engineer for review and approval and allow 5 calendar days from the date they are received until they are returned by the Engineer.

A pre-construction meeting must be held prior to the start of the work and must be attended by representatives from the Prime Contractor, Wall Subcontractor, Resident Engineer, Materials and Test Unit, and Geotechnical Engineering Unit to discuss construction details and inspection of the wall construction. Review of all submittals must be completed prior to scheduling the pre-construction meeting.

No value engineering construction proposal will be allowed.

2.0 Design Criteria:

Wall design must be in accordance with the criteria set forth in the AASHTO Specifications for Highway Bridges and the FHWA Manual "Ground Anchors and Anchored Systems Manual", Publication No FHWA-IF-99-015.

Use the soil parameters shown on the plans to design the tieback wall.

Design all wall components for a 100-year design life.

Include calculations and details of the precast concrete facing in the design package. Design a minimum 6 inch (150 mm) thick precast concrete facing to be constructed on a minimum 6 inch (150 mm) thick by 12 inch (300 mm) wide unreinforced concrete leveling pad. Construct the concrete facing of the tieback retaining wall in accordance with Section 825 of the Standard Specifications with an ordinary surface finish.

Embed the wall a minimum of 24 inches (600 mm) below the proposed finished grade in front of the wall.

Install soldier piles a minimum of 5 feet (1.5 meters) into competent bedrock.

Install permanent tieback anchors through boulder fill into competent bedrock.

Provide plans containing sufficient information to lay out and construct the wall including but not limited to the following:

1. Elevation views showing all proposed and existing ground lines and stations, soldier piles, precast concrete facing panels, leveling pad elevations, construction joint locations.

2. Plan views showing all horizontal layout information.

3. Section views showing in detail all wall components, the proximity of other structures, proposed and existing ground lines, etc.

4. Specific details of wall components.

5. Construction sequence.

3.0 Materials:

All materials are to be as specified or better, and as approved by the Engineer. Submit requests for substitutions to the Engineer five days before intended installation.

A. Fabricate tieback tendons from single or multiple elements of the following:

1. Steel bars conforming to ASTM Designation A722, "Uncoated High-Strength Steel Bars for Prestressed Concrete."

2. Seven-wire strand conforming to ASTM Designation A416/416M, "Uncoated Seven-Wire Stress-Relieved Strand for Prestressed Concrete."

3. Compact seven-wire strands conforming to ASTM Designation A779, "Uncoated Seven-Wire Compacted, Stress-Relieved Steel Strand for Prestressed Concrete."

Submit to the Engineer mill test reports for each heat or lot of prestressing material used to fabricate tendons.

B. Submit cement anchor grout mix design to the State Materials Engineer for approval. Supply Portland Cement conforming to ASTM Specification C-150, Type

I, II, or III, and potable water. Supply cement that is fresh, free from lumps or any indication of hydration. Use admixtures that will impart low water content, flowability and minimum bleeding in the cement grout only with the consent of the Engineer. Do not use admixtures that contain chemicals that may have a harmful effect on the prestressing steel or cement. If admixtures are to be used, submit to the Engineer prior to using the admixture, the manufacturer's literature indicating the type of admixture and the manufacturer's recommendations for mixing the admixtures with grout. Expansive additives which cause air bubbles in the grout will not be allowed. Use grouting equipment that includes a mixer capable of producing a grout free of lumps and undispersed cement. Use a positive displacement grout pump. Equip the pump with a pressure gauge to monitor grout pressures at the nozzle, using a gauge capable of measuring pressures of at least 150 psi (1035 kPa), or twice the actual grout pressures used.

Size the grouting equipment to enable the tieback to be grouted in one continuous operation. Use mixing and storage times that do not cause excessive temperature build-up in the grout. Use a mixer capable of continuously agitating the grout.

C. Use anchorage and hardware suitable for the type of anchor tendon used and capable of developing 95% of the guaranteed specified minimum ultimate tensile strength of the tendon when tested in the unbonded state without failure of the tendon. Supply anchorage devices capable of holding the prestressing steel at a load producing a stress of not less than 95% of the guaranteed specified minimum ultimate tensile strength of the prestressing steel without exceeding anticipated set and without failure of either the anchorage or the prestressing steel. Anchorages shall be capable of lift-off, detensioning or retensioning a tendon at any time prior to grouting.

Fabricate the bearing plate from steel plate conforming to AASHTO M270 Grade 250 Specifications. Size the bearing plate so that the bending stress in the plate does not exceed 0.75 times the yield strength of the steel at the tieback design load or 1.00 times the yield strength of the steel at the maximum tieback test load.

Provide polyvinyl chloride (PVC) trumpets made from Type I, Schedule 40, Grade PVC 1120 pipe conforming to the requirements of ASTM D-1785. The plastic material shall be resistant to aging by ultra-violet light.

Provide steel trumpets made from pipe or tube conforming to the requirements of ASTM A-53 for pipe and ASTM A-500 for tubing.

Provide trumpets with an inside diameter equal to or larger than the hole in the bearing plate furnished by the tendon supplier, and long enough to accommodate movements of the structure during testing and stressing. For strand tendons, consult the tendon supplier to determine the minimum length trumpet required to make a transition from the diameter of the tendon in the unbonded length to the diameter of

the tendon at the anchorhead. Provided a watertight seal between the trumpet and the unbonded length corrosion protection.

If grout is used to fill the trumpet, then the seal is temporary and it acts as a grout form. If corrosion inhibitor is used to fill the trumpet, then the seal is permanent and it shall be fabricated from Buna-N-synthetic rubber or equal.

Furnish anchor nuts and plates for bars having complementary spherical shapes at the contact areas.

Furnish anchorheads of either steel meeting the requirements of AASHTO M270 Grade 250, or cast ductile iron meeting the requirements of ASTM A-536 Grade 80-55-06.

D. Use corrosion inhibitor (grease) conforming to the following test requirements:

Chlorides	10 ppm max.	by ASTM B-512
Nitrates	10 ppm max.	by ASTM D-992
Sulfides	10 ppm max.	by APHA 427D(15th ED)

The corrosion inhibitor (grease) must remain ductile and free from cracks and must not become fluid over the anticipated range of temperatures encountered during fabrication, transport, storage and while in service. The inhibitor must be impervious to moisture and air, be a self-healing film and displace water. The corrosion inhibitor must have a reserve alkalinity for long-term acid neutralization.

E. Epoxy Coating: Epoxy coating must be an electrostatically applied coating meeting M-284 (ASTM A-775). Any required field patching must meet ASTM A-775 or ASTM D-3196.

F. Corrugated Tubes: The following corrugated tubes will be acceptable:

1. High density corrugated polyethylene (PE) tubing conforming to the requirements of AASHTO M252-851.

2. High density corrugated polypropylene (PP) tubing manufactured from plastic classified as Type II-26500-D by ASTM D-2146. The minimum wall thickness of the tubing shall be 0.04 inches (1.0 mm).

3. Corrugated polyvinyl chloride (PVC) tubes with a minimum wall thickness of 0.04 inches (1.0 mm).

G. Heat Shrinkable Tube: Heat shrinkable tubing must have an outer heat shrinkable polyethylene plastic internally coated with a thixotropic sealant. Recovered wall

thickness must be at least 0.04 inches (1.0 mm). Coating thickness must be at least 0.02 inches (0.50 mm).

H. Bondbreaker: Use any of the following bondbreakers:

1. Bar Tieback Tendon: Low density polyethylene tubing, polypropylene tubing or polyvinyl chloride tubing with a minimum wall thickness of 0.06 inches (1.50 mm).
2. Strand Tieback Tendon: A polyethylene tube or a hot melt extruded polypropylene tube with a minimum wall thickness of 0.06 inches (1.50 mm).

I. Electrical Insulation: The electrical insulation must be a multipolymer plastic sheet manufactured expressly for bearing purposes. Fabricate the electrical insulation from a material that is: an electrical insulator; resistant to attack from cement; the corrosion inhibitor, or the environment; nondetrimental to the prestressing steel; prevents oxygen and moisture from coming in contact with the anchorage or bearing plate; and is capable of withstanding atmospheric exposure and ultra-violet light degradation if the anchorhead is to remain exposed to the atmosphere.

J. Steel members used as soldier piles must conform to the applicable sections of the Standard Specifications. Steel piles must contain 0.2% minimum copper, and must be ASTM Grade A36 or better. Stiffeners at the anchor location must be 0.75 inch (19 mm) thick steel plates and must be ASTM Grade A36 or better and 0.2% copper, or must be painted (including welds) with two coats of zinc-rich paint.

K. Concrete and reinforcing steel must conform to the applicable sections of the Standard Specifications.

L. Concrete for coping must be Class A and conform to the applicable requirements in sections 420 and 1000 of the Standard Specifications. Reinforcing Steel in coping must conform to the applicable requirements in sections 425 and 1070 of the Standard Specifications.

M. Filter fabric on the backside of the wall, used in conjunction with a granular material or with a molded, polymeric core must conform to Section 1056-1 of the Standard Specifications.

N. Drain pipes installed along the lower portions of the wall near the leveling pad or footing must conform to Section 815 of the Standard Specifications.

O. Timber lagging must conform to the requirements of Section 1082-1 of the Standard Specifications and Table 16 entitled Recommended Thickness of Wood Lagging in Appendix C of the AASTHO "Construction Handbook for Bridge Temporary Works" or page 82 of FHWA Ground Anchors Manual.

P. Class VI Select Material (#57 Stone) must conform to the requirements of Section 1005 and Section 1016 of the Standard Specifications.

4.0 Concrete Panels

Cast concrete face panels and apply the requirements of Sections 1000 and 1077 of the Standard Specifications.

A. Materials and Fabrication

Supply concrete for precast panels that attains the 28 day compressive strength as required by the submitted tie back wall design and plans.

Provide materials and fabricate members in accordance with the requirements of Division 10 of the Standard Specifications for Roads and Structures.

B. Miscellaneous

1. Casting

Set all panel components in place in the forms to conform to the details on the plans and accepted shop plans prior to casting. Cast the panels on a flat area with the front face of the form at the bottom and the rear face at the top.

2. Concrete Finish

Provide an ordinary surface finish as defined by Subarticle 420-18(B) of the Standard Specifications for the front face (exposed face of wall). Screed the rear face of the panel to a uniform surface finish to eliminate open pockets of aggregate and surface distortions in excess of 1/4 inch (6 mm).

3. Tolerances

Manufacture all units within the following tolerances:

a. All dimensions within 3/16 inch (5 mm).

b. Surface defects on formed surfaces are not to exceed 1/8 inch in 5 feet (3mm in 1.5 m).

3. Marking

Clearly scribe the date of manufacture, the production lot number, and the piece-mark on the rear face of each panel.

4. Handling, Storage and Shipping

Handle, store and ship all units in such manner as to eliminate the danger of discoloration, chipping, cracks, fractures and excessive bending stresses. Support panels in storage on firm blocking. Store panels in a horizontal position and stack no more than six high.

5.0 Corrosion Protection:

A. General:

Prestressed anchors and the anchor head assembly must be doubly protected against corrosion. The cement grout in the bond zone constitutes one protection system; cement grout in the unbonded zone does not constitute a protection system. Corrosion protection begins with the storage, fabrication, and handling of the tendon components prior to insertion in the borehole. Proper care is required to avoid prolonged exposure to the elements, and to avoid mechanical or physical damage which would reduce or impair the future ability of the components to resist any adverse conditions encountered during their service life.

B. Tendon Fabrication:

Fabricate tendons in accordance with approved details and free of dirt, detrimental rust, or other deleterious substances. Install the plastic sheath at the fabrication shop as a single piece without splices. Field installation of the plastic sheath shall not be allowed. Prior to installation, handle and store tendons in such a manner as to avoid corrosion and physical damage. Field repair damaged coatings with ultra-high molecular weight polyethylene tape or heat shrinkable tubing. Damage such as abrasions, cuts, nicks, welds, weld splatters, or heavy corrosion and pitting, will be cause for rejection of the tendon. Replace rejected tendons at no cost to the Department in terms of either material replacements and/or resulting time delays.

1. Strand Tendon:

Apply a polyethylene tube or a hot-melt extruded polypropylene tube over a corrosion inhibiting grease coated strand for the entire unbonded length of each individual strand of the tieback tendon. Coat the individual wires of each tendon with grease to completely fill the space between the tube and the strand, making provisions to prevent the grease from escaping at the ends of the tubes. Place the bond length and lower two feet of the unbonded length in a corrugated tube. Centralize the tendon within the corrugated tube with a

minimum of 0.02 inches (0.50 mm) of grout cover. Use spacers along the bond length to separate the strands so the tendon will bond to the encapsulation grout. Mix with the encapsulation grout, if desired, admixtures which control bleed water, improve flowability, reduce water content and are expansive. Three options for grouting inside the encapsulation are available:

a. Grout the tendons inside the encapsulation after the tendon has been placed in the drill hole, or

b. Grout the tendons inside the encapsulation prior to inserting the tendon in the drill hole and then place in the drill hole provided the grout has not achieved initial set or a maximum of 45 minutes, or

c. Grout the tendons and allow to set inside the encapsulation for a period of 24 hours prior to inserting the tendon in the drill hole. In this case, support the entire length of tendon at sufficient intervals during installation such that excessive bending does not occur.

2. Bar Tendon:

Epoxy coat the bar tendon with a minimum thickness of 0.008 inches (0.20 mm). Install a tight fitting bondbreaker around the encapsulated bar over the unbonded length.

6.0 Construction:

A. Excavation and Backfill:

Coordinate scheduling with the Wall Subcontractor such that earthwork and wall construction can be accomplished at a minimum of delay to each.

Excavation must be in reasonably close conformity to the limits and construction stages shown on the plans or specified in the contract and limited to that necessary to install the lagging.

B. Temporary Earth Support:

Construct temporary earth support between soldier piles such as to be safe and provide adequate resistance to earth loads. Use sound materials, free of defects, and placed in a workmanlike manner.

Fill small voids behind the lagging with hand tamped on site soils.

C. Soldier Piles:

Set all soldier piles in pre-augered or drilled holes. Keep holes open, if required, by casing or other means approved by the Engineer. Place concrete such that free fall greater 5 feet (1.5 meters) does not occur. Use a lean sand grout mixture to fill the remainder of the hole to the ground surface. Remove this mixture as required to install the timber lagging. Set piles and concrete holes as soon as practical after drilling. At no time shall more than 5 holes be left open before setting piles and concreting.

Shaft excavation must conform to the applicable provisions of Section 410 of the Standard Specifications. Haul off and waste material resulting from shaft excavation. Do not place shaft excavation on the slope. Provide Class A concrete meeting the requirements of Section 1000 of the Standard Specifications or as approved by the Engineer. Design the Class "A" concrete with a 6-inch to 8-inch slump.

Cast shaft concrete against undisturbed ground unless otherwise permitted by the Engineer, and construct in accordance with Section 825 of the Standard Specifications. If over-excavation occurs vertically, backfill with #57 Stone Backfill before setting the pile. Remove all loose and soft material and dewater the excavation immediately before and during the concrete casting operation. Make the top of the concrete shafts generally level.

D. Anchor Installation:

The holes for the anchors must be drilled. Core drilling, rotary drilling, auger drilling or percussion drilling may be used. If water is used in the drilling operation, dispose of the water in such a manner that erosion of the wall site is minimized. *Any damage to the site by water erosion shall be repaired by the Contractor at no cost to the Department.* If the hole will not stand open, install casing as required to maintain a clean and open hole. Provide a hole diameter not less than 3 inches (75 mm) if no pressure grouting is used. Pressure grouting is defined as grouting with a pressure greater than 60 psi (415 kPa). Use a drill bit with a diameter not less than 0.12 inches (3 mm) smaller than the specified hole diameter. The hole shall be within 3 inches (75 mm) of plan location and drilled to the inclination specified on the approved design plans within a three degree tolerance. Do not extend holes outside the right-of-way limits. Thoroughly clean holes in rock of all dust, rock chips, grease or other deleterious material prior to inserting the tendon.

Install the tendon in the casing or hole drilled for the anchor, taking care to insure that the tendon's corrosion protection is not damaged during handling or installation. If the sheathing has been damaged, repair it with ultra high molecular weight PE tape. Wind the tape spirally around the tendon so as to completely seal the damaged area. Use a pitch of the spiral to ensure a double thickness at all points. Install the tendon in the bond length in such a way as to insure that it has a minimum of 0.5 inch (13 mm) grout

cover. Degrease the bond length of strands or wires prior to installation by using Acetone, MEK, or MIBK leaving no residue on the tendon. Other substances may be used subject to approval by the Engineer. Include all costs of cleaning tendons in the price bid for Contract items.

Drill holes 1 foot (0.3 meter) minimum longer than tendons. Insert the tendon after the hole is drilled to the final depth. Do not subject anchor tendons to sharp bends. Provide centralizers at maximum 10 foot (3.0 meters) center-to-center spacing throughout the bond length to insure that the tendons do not contact the wall of the drill hole, with the lowest centralizer no more than 5 feet (1.5 meters) from the bottom of the bond length. Do not use centralizers made of wood or any other material detrimental to the tendon steel or sheathing. If multi-element tendons are used without a fixed anchorage at the lower end, provide adequate spacing of the tendon elements to achieve proper grout coverage. Do not use anchors for grounding electric equipment.

Perform the grouting operation after the tendon is inserted. Inject grout at the lowest point of the anchor. Place grout over the entire anchor length. Do not allow the top of the grout column to contact the wall or the trumpet. After grouting, the tendon shall remain undisturbed until the grout has cured for at least 72 hours. Record the following data during the grouting operation:

a. Type of mixer
b. Water/cement ratio
c. Type of additives
d. Grout pressure
e. Type cement
f. Test sample strengths (prior to stressing)
g. Volume of grout placed in bond and free lengths

After lockoff of the post-tension force, fill the trumpet with non-bleed, expansive grout, or grease. Coat the exposed surface of the anchorage with mastic, and cover with a metal cap or Portland Cement concrete.

E. Anchor Testing and Stressing:

Each anchor must be tested. The maximum test load must not exceed 80% of the guaranteed ultimate tensile strength of the tendon. Conduct performance tests for the first two anchors installed for each specified design load capacity and 5% of the remaining anchors at locations to be chosen by the Engineer. Proof test all remaining anchors. Install no additional anchors until the first two anchors have been successfully performance tested.

Anchors extending through #57 stone fill must not be fully tensioned until fill is placed to the full height of the wall. Anchors may be partially tensioned only once fill has been placed to the same level as the anchors. The partial tension load must not cause the soldier piles to move out of alignment tolerances.

1. Performance Tests:

   Do performance tests by incrementally loading and unloading the anchor in accordance with the following schedule. Record the movement of the tendon to the nearest 0.001 inch (0.025 mm) with respect to an independent fixed reference point. The jack and pressure gauge shall have been calibrated as a unit. Use a pressure gauge graduated in 100 psi (700 kPa) increments or less. Use a master gauge to verify the accuracy of the production gauge at the beginning of each shift.

Cycle	Load
1	0
	0.25P
	AL
2	0.25P
	0.50P
	0.25P
	AL
3	0.50P
	0.75P
	0.50P
	AL
4	0.50P
	0.75P
	1.00P
	0.75P
	0.50P
	AL
5	0.50P
	0.75P
	1.00P
	1.20P
	1.33P
	1.20P
	1.33P*

Adjust to lockoff load.
Actual lock-off loads may be somewhat higher to account for seating losses.
* Hold 50 minutes for creep test.

AL (Alignment Load)
P (Design Load)

   To prevent misalignment of testing equipment, maintain a minimum Alignment Load (AL) of 0.05P.

   Hold each load increment until movement ceases, or a minimum of 1 minute. Submit loading and unloading rates (tons per minute) for approval. Apply each load in less than 30 seconds after the jack pump is started.

Perform a Creep Test by holding the 1.33P load for 50 minutes. While maintaining a constant load, record anchor movement (total movement) at 0, 1/2, 1, 3, 5, 10, 20, 30, 40 and 50 minutes. Begin the observation time when load is applied to the pump.
The Engineer will review all performance tests to determine if the anchor is acceptable. An anchor shall be acceptable if:

1) The total elastic movement obtained exceeds 80% of the theoretical elastic elongation of the free length.

2) The creep movement does not exceed 0.08 inches (2 mm) during the 5 minutes to 50 minutes time increments regardless of tendon length and load.

2. Proof Tests:

Perform proof tests by incrementally loading and unloading the anchor in accordance with the following schedule. Record the movement of the tendon to the nearest 0.001 inch (0.025 mm) with respect to an independent fixed reference point. Monitor the jack load with a pressure gauge or load cell.

0
0.25P
0.50P
0.75P
1.00P
1.20P
1.33P (Hold for creep test)
Adjust to lockoff load.

Actual lockoff load may be somewhat higher to account for seating losses.

Perform a Creep Test by holding the 1.33P load for 5 minutes. Holding the load constant, record anchor movement (total movement) at 0 second, 30 second, 1 minute, 3 minute, and 5 minute intervals. Begin observation times the moment the jack begins to apply the 1.33P load. If the movement between the 30 second and the 5 minute reading is 0.08 inches (2 mm) or more, maintain the load for an additional 45 minutes and record the movement at 10, 20, 30, 40, and 50 minutes. Record all movements in relation to a fixed reference point. The acceptance criteria shall be as in A and B above.

3. Lift-Off Tests:

Make a lift-off reading of all anchors after transferring the load to the end anchorage and prior to removing the jack. The load determined shall be within 5% of lockoff load. If the lift-off load is not within this tolerance, reset the end

anchorage and make another lift-off reading. Perform lift-off tests within 7 days of when the load was locked-off in the anchor.

After five lift-off tests are performed, the Engineer will *specify* lift-off tests be performed on a random basis such that the total number of tests will be on no more than 10% of the remaining anchors.

4. Cutting of Tendon Protrusions:

After an anchor has been accepted by the Engineer, the portion of the anchored tendon protruding over the anchor may be cut, if not otherwise required for use in retesting. Cutting must be done according to the tendon manufacturer's recommendations as approved by the Engineer. Care must be taken not to damage the tendon anchor.

5. Redesign:

If anchors fail during performance tests or proof tests, modify the design or construction procedures, subject to review by the Engineer. These modifications may include reducing the anchor design load by increasing the number of anchors, increasing the grout pressure, requiring post-grouting or increasing the bond length. Any modification of design or construction procedure will be at no cost to the Department. Install the redesigned anchors in the wall and test as previously defined at no cost to the Department.

Those anchors that fail the performance or proof tests may be incorporated in the wall. Propose a reduced Design Load and retest as noted above. Acceptance of such anchors will be at the discretion of the Department.

7.0 Records

Provide the Engineer with the following records:

1. As-built drawings showing the location of the tiebacks, total tieback length, anchor length, and unbonded length one month after completion of the tieback installation.

2. Steel and grout certifications and mill reports prior to incorporating these materials in the work.

3. Grouting records indicating the cement type, quantity injected, and the grout pressures twice a week.

4. Tieback test results twice a week.

8.0 Method of Measurement

A. Permanent Anchor Tieback Retaining Wall - The quantity of Permanent Anchor Tieback Retaining Wall to be paid for will be the actual final square feet (square meters) of exposed retaining wall face. Measurement will be made vertically from the finished grade at the bottom of the wall to the bottom of the concrete coping.

B. Class VI Select Material (#57 Stone) - The quantity of Class VI Select Material to be paid for will be the actual number of cubic yards (cubic meters) of this material which has been placed as backfill behind the wall within the limits as shown on the plans and as directed by the Engineer.

C. Grout for Tieback Anchors - The quantity of Grout for Tieback Anchors to be paid for will be the actual number of cubic yards (cubic meters) of this material which has been placed as shown on the plans and as directed by the Engineer.

9.0 Basis of Payment

A. Permanent Anchor Tieback Retaining Wall

Payment will include all costs for concrete, reinforcing steel, shaft excavation, lagging, piles, anchors, furnishing and placing precast concrete panels, labor, design and all other materials and equipment including but not limited to drilling holes, post-tensioning, performing and evaluating all tests, submitting records of tests, all tools and all other miscellaneous items necessary to complete the work, including concrete coping and drainage above and below wall, with the exception of the items noted below.

Excavation of the material in front of the retaining wall will be paid for as "Unclassified Excavation" in accordance with Section 225 of the Standard Specifications.

Payment will be made under:

"Permanent Anchor Tieback Wall No. 1,
Sta 17+00.00 to Sta 22+25.00 .....Square Feet (Square Meter)

"Permanent Anchor Tieback Wall No. 2,
Sta 33+00.00 to Sta 35+00.00 .....Square Feet (Square Meter)

B. Class VI Select Material (#57 Stone)

The quantity of Class VI Select Material (#57 Stone), measured as provided above will be paid for at the contract unit price per cubic yard (cubic meter) for "Class VI

Select Material for Permanent Anchored Wall". Such price and payment will be considered full compensation for furnishing, hauling, excavating into existing ground, and compacting the backfill material necessary to complete the work satisfactorily.

Payment will be made under:

"Class VI Select Material for Permanent Anchored Wall No. 1
Sta 17+00.00 to Sta 22+25.00".....Cubic Yard (Cubic Meter)

C. Grout for Tieback Anchors

The quantity of Grout for Tieback Anchors, measured as provided above will be paid for at the contract unit price per cubic yard (cubic meter) for "Tieback Anchor Grout". Such price and payment will be considered full compensation for furnishing, mixing, placing submitting records of tests, all tools and all other miscellaneous items necessary to complete the work

Payment will be made under:

"Grout for Tieback Anchors at Wall No. 1,
Sta 17+00.00 to Sta 22+25.00 ".....Cubic Yard (Cubic Meter)

" Grout for Tieback Anchors at Wall No. 2,
Sta 33+00.00 to Sta 35+00.00".....Cubic Yard (Cubic Meter)

GEOTECHNICAL ENGINEERING SCOPE OF WORK

1.0 GENERAL

The scope of work consists of developing an engineered retention system to safely re-open all lanes of traffic to the traveling public on I-40 between Mile Marker 3 and 4. The system will mitigate the 2 landslides on I-40 that have occurred as a result of the recent hurricanes.

Construct the retention system to stabilize the roadway before beginning any work for the toe scour protection.

The retention system and toe scour protection will be maintenance free.

The geotechnical firm should prepare geotechnical design recommendation reports for use in designing embankments, slopes, buttresses, retaining walls, toe scour protection, and temporary structures. The geotechnical firm should also determine if additional subsurface information is required based upon the subsurface information provided by NCDOT and the final roadway and structure designs. Perform any additional subsurface investigation and laboratory testing in accordance with the current NCDOT *Geotechnical Unit Guidelines and Procedure Manual*.

2.0 DESCRIPTION OF WORK

Design slopes, buttresses, retaining walls, toe scour protection, and temporary structures in accordance with the current allowable strength design AASHTO *Standard Specifications for Highway Bridges*, NCDOT *Structure Design Manual*, NCDOT *Roadway Design Manual* and the Geotechnical Engineering Unit *Roadway and Structure Foundation Guidelines*.

A. Slopes

Design all slopes to be maintenance free. Design all unreinforced fill slopes for a slope of 2:1 (H:V) or flatter and a minimum stability factor of safety of 1.3. Design all cut slopes for a slope of 1.5:1 (H:V) or flatter and a minimum stability factor of safety of 1.5. Use limiting equilibrium methods, such as Modified Bishop, Simplified Janbu, Spencer or any other generally accepted method for slope stability analysis.

B. Buttresses

Design all buttresses to be maintenance free. Design all buttresses for a minimum stability factor of safety of 1.3. Use limiting equilibrium methods, such as Modified Bishop, Simplified Janbu, Spencer or any other generally accepted method for slope stability analysis.

C. Retaining Walls

Design all permanent retaining walls to be maintenance free. Extensible reinforcement is not allowed for any permanent retaining walls. Modular block

walls are not allowed for critical wall structures. Critical wall structures include walls supporting or adjacent to interstate highways, bridge abutments, wing walls and walls over 18 feet (5.5 meters) in height.

The following list of retaining wall types are acceptable for consideration for permanent applications:

- Gravity wall
- Cast-in-place cantilever wall
- Modular block wall
- Mechanically stabilized earth (MSE) wall
- Soldier pile cantilever wall with either a cast-in-place face or precast panels
- Anchored tieback wall
- Soil nail wall

Design and construct permanent retaining walls, with the exception of gravity walls and cast-in-place cantilever walls, in accordance with the applicable NCDOT *Project Special Provisions*. For each retaining wall, with the exception of gravity walls, submit a wall layout and design. The wall layout submittal should include the following:

- Wall envelope with top of wall, bottom of wall, existing ground and finished grade elevations at incremental stations.
- Wall alignment with stations and offsets.
- Typical sections showing top and bottom of wall, drainage, embedment, slopes, barriers, fences, etc.
- Calculations for bearing capacity, global stability and settlement.
- Details of conflicts with utilities and drainage structures.
- Roadway plan sheets showing the wall (half size).
- Roadway cross sections showing the wall (half size).
- Traffic control plans showing the wall (half size).

Gravity walls must be designed and constructed in accordance with the NCDOT Roadway Standard Drawings and the NCDOT 2002 *Standard Specifications*. Gravity walls do not require any submittals. Cast-in-place cantilever walls must be designed and constructed in accordance with the NCDOT 2002 *Standard Specifications.*

Any slopes behind walls are required to be 2:1 (H:V) or flatter. Embed retaining walls in accordance with FHWA Manual Demonstration Project 82 Reinforced Soil Structures MSEW and RSS or a minimum of 2 feet (600 mm), whichever is greater. The wall embedment depth is from the grade that intersects the front of the wall (either finished grade or natural ground elevation) or 100 year scour elevation, whichever is lower, to the top of the leveling pad.

Drainage over the top of retaining walls is not allowed. Sags in the top of walls should be avoided. Direct runoff above and below walls away from walls, if possible, or collect runoff at the walls and transmit it away. Curb and gutter or cast-in-place single faced barrier with paving up to the wall is required when runoff can not be directed away from the back or front of the wall. A paved concrete ditch with a minimum depth of 6 inches (150 mm) is required at the top of walls when slopes steeper than 6:1 (H:V) intersect the back of walls.

Precast or cast-in-place coping is required for walls without a cast-in-place face with the exception of when a barrier is integrated into the top of the wall. Extend coping or cast-in-place face a minimum of 6 inches (150 mm) above where the finished or existing grade intersects the back of the wall. Design concrete barriers integrated into retaining walls for traffic impact in accordance with AASHTO. A fence is required on top of the facing, coping or barrier or immediately behind the wall if there is no slope behind the wall.

D. Toe Scour Protection

Design all toe scour protection to be maintenance free. Design a toe scour protection system that is flexible, durable, impact and abrasion resistant and maintenance free. Design the toe scour protection system to withstand, intact, a sustained peak flow of 41,000 ft^3/sec that is 20 feet in height above the stream bed.

Design and construct the toe scour protection system in accordance with FHWA *Hydraulic Engineering Circular No. 11 Design of Rip Rap Revetment.*

E. Temporary Structures

Design temporary retaining structures, which include earth retaining structures and cofferdams, in accordance with Section 4 of the 1995 or current allowable stress design AASHTO *Guide Design Specifications for Bridge Temporary Works* and the NCDOT Temporary Shoring for Maintenance of Traffic Special Provision. The only submittal required to use the standard sheeting design is the "Standard Shoring Selection Form".

Design and construct temporary retaining walls in accordance with the applicable NCDOT *Project Special Provision.* For temporary retaining walls, do not place a barrier within 5 feet (1.5 meters) of the face of the wall. If the barrier is between 5 and 9 feet (1.5 to 2.7 meters) from the face of the wall, anchor the barrier in accordance with Roadway Standard Detail No. 11.70.01.

3.0 SUBMITTALS

Submit all slope, buttress, retaining wall, toe scour protection, and temporary structure designs for review. Seal all design recommendation reports, plans, special provisions and calculations by a registered professional engineer licensed in the state of North Carolina.

If temporary shoring is required to construct a retaining wall, submit the temporary shoring design as part of the wall design submittal. A review time of 3 business days is required for each submittal.

4.0 CONSTRUCTION REQUIREMENTS

All construction and materials must be in accordance with the NCDOT 2002 *Standard Specifications* and current NCDOT *Project Special Provisions*. The Contractor is responsible for investigating and proposing remedial measures for any construction problems related to foundations, retaining walls, subgrades, settlement, slopes, and construction vibrations. The NCDOT Geotechnical Engineering Unit will review and approve these proposals.

Do not allow vibratory compaction of fill within 100 feet (30 meters) of any existing structure. Do not allow pile driving or subsurface drilling of foundations within 500 feet (150 meters) of any existing structure. If these requirements can not be met or damage occurs to any existing structure, employ the services of a qualified private engineering firm experienced in the effects of construction induced vibrations on existing structures, to do a study of the structure's response to vibration. The purpose of this study is to set vibration limits to avoid damage to the existing structure and provide modifications to construction methods as necessary. Any existing structure is not intended to include existing bridges unless they are historic or will remain in service upon completion of construction. Existing bridges used for detours that will be taken out of service upon completion of construction should be protected from vibration damage to the extent necessary for the safety of the traveling public.

Geotechnical Engineering Unit

ROADWAY AND STRUCTURE FOUNDATION GUIDELINES

The geotechnical firm is responsible for (but not limited to) addressing the following items for the roadway and structure foundation design of the project.

1. Analyze the stability of embankments and utilize recognized geotechnical engineering designs and construction methods to ensure embankment stability.
2. Determine the feasibility and recommend types of retaining walls or shoring for permanent or temporary situations. Design all retaining walls in accordance with the current allowable stress design AASHTO *Standard Specifications for Highway Bridges* and applicable FHWA manuals.
3. Analyze the stability of cut sections. Utilize recognized geotechnical engineering designs and construction methods to ensure cut slope stability.

The geotechnical firm's attention is directed to the latest design guide entitled *Soils and Foundations Workshop Manual*, NHI Course No. 13212, Publication No. FHWA HI-88-009, published by the FHWA.

TOE SCOUR PROTECTION

1.0 GENERAL

Construct the Toe Scour Protection in accordance with Section 235 of the 2002 Standard Specifications, the details shown on the plans, this provision, and as directed by the Engineer. Schedule a preconstruction meeting with representatives of the Contractor, Geotechnical Engineering Unit, and the Engineer.

The Toe Scour Protection will be required at Stations 15+00 ± to 21+75 ± -L-, and at Stations 32+75 ± to 35+25 ± -L-, and other locations as directed by the Engineer.

Density requirements will not apply to the Toe Scour Protection construction, but compact to the satisfaction of the Engineer.

2.0 CONSTRUCTION

Unless otherwise directed by the Engineer, construct the Toe Scour Protection with the slopes as indicated on the plan detail. Grade the rock so that the smaller pieces are uniformly distributed throughout the mass. The surface must be free of obstructions, debris, and segregated pockets of small pieces or groups of large pieces, which could cause large open voids within the rock mass.

Place Filter Fabric as detailed in the plans. Grade the surfaces that receive Filter Fabric to lines and grades shown on the plans, unless otherwise directed by the Engineer. The surface must be free of obstructions, debris, and large voids.

At the time of installation, the Filter Fabric will be rejected if it has defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation or storage.

Lay the Filter Fabric smooth and free from tension, stress, folds, wrinkles, or creases. Where a layer of Filter Fabric becomes discontinuous, such as at the end of a roll, a minimum overlap of 12 inches is required with the upper fabric placed over the lower fabric. Use wire staples as needed to hold the fabric in place until it is covered with fill material. Do not operate equipment directly on the fabric. In the event fabric is displaced or damaged, reposition or replace the fabric at no additional cost to the Department.

Place the Rock Embankment Material in maximum 4-foot lifts.

Place a 9-inch thick layer of Rip Rap, Class A on top of each lift of the Toe Scour Protection.

Place Select Material, Class VI (#57 stone backfill) on top of the final lift of Rip Rap, Class A. Compact #57 stone backfill with at least four passes of an 8 - 10 ton (or heavier) vibratory roller in the vibratory mode, or as directed by the Engineer.

Lay the Ring Nets smooth and free from folds, wrinkles, or creases. Where a layer of Ring Nets becomes discontinuous, such as at the end of a roll, a minimum overlap of 12 inches is required with the upper Ring Net placed over the lower Ring Net. Stake as needed to hold the ring nets in place until it is covered with fill material. Do not operate equipment directly on the Ring Nets. In the event the Ring Nets are displaced or damaged, reposition or replace the Ring Net at no additional cost to the Department.

3.0 MATERIALS

A. Rock Embankment Material

For the purposes of this provision Rock Embankment Material refers to clean, non-degradable, durable, blasted rock material with a diameter of at least 2 feet but not greater than 4 feet. The Contractor shall identify the material source for approval by the Engineer before the preconstruction meeting. On-site material meeting the 2 to 4 foot diameter criteria may be used. The rocks must have a minimum density of 160 pounds per cubic foot and a minimum weight of 1200 pounds each.

B. Select Material, Class VI

The top 12 inches of the material on top of the Toe Scour Protection must be Select Material, Class VI (#57 stone) meeting the requirements of Section 1016 of the 2002 Standard Specifications.

C. Rip Rap, Class A

The top of each lift must be Rip Rap, Class A meeting the requirements of Section 1042 of the 2002 Standard Specifications.

D. Filter Fabric

For Filter Fabric use Type 2 Engineering Fabric meeting the requirements of Section 1056 of the 2002 Standard Specifications. Furnish a Type 1 Certified Mill Test Report, Type 2 Certified Mill Test Report, or Type 4 Certified Mill Test Report for the fabric in accordance with Article 106-3; however, the material will be subject to inspection, test, or rejection by the Engineer at any time.

E. Ring Net

Obtain Ring Net materials from

Geobrugg North America, LLC
Geobrugg Protection Systems
551 W. Cordova, PMB 730
Santa Fe, New Mexico 87505
(505) 438-6161
www.us.geobrugg.com

The Ring Nets shall be ROCCO 12/3/300. The nets shall be made from interlocking steel rings, each ring with a nominal diameter of 12 inches. Rings shall be composed of steel wire coiled into a loop with 12 loops per ring. Three steel clips shall be fastened around each ring to hold the ring together. Each ring shall connect to the four adjoining rings by passing through them.

The Ring Nets shall be manufactured and assembled in accordance with the contract documents and plans and the manufacturer's standards and requirements.

The wire shall be high tensile strength alloy steel wire with a nominal diameter of 0.118 inches and the minimum tensile strength of the wire shall be 256,000 pounds per square inch.

The wire shall be galvanized with Supercoating®, a 95% zinc / 5% aluminum coating, and the minimum weight of the coating shall be 0.655 ounces per square foot.

4.0 METHOD OF MEASUREMENT

A. Rock Embankment Material

The quantity of Rock Embankment Material to be paid for will be the actual number of tons, which has been incorporated into the completed and accepted work. The material will be measured by weighing in trucks on certified platform scales or other certified weighing devices or by methods approved by the Engineer.

B. Select Material, Class VI

The quantity of Select Material, Class VI (#57 stone) to be paid for will be the actual number of tons, which has been incorporated into the completed and accepted work. The material will be measured by weighing in trucks

on certified platform scales or other certified weighing devices or by methods approved by the Engineer.

C. Rip Rap, Class A

The quantity of Rip Rap, Class A to be paid for will be the actual number of tons, which has been incorporated into the completed and accepted work. The material will be measured by weighing in trucks on certified platform scales or other certified weighing devices or by methods approved by the Engineer.

D. Filter Fabric

The quantity of Filter Fabric to be paid for will be the area in square yards, measured along the surface of the ground, over which the fabric has been acceptably placed. No separate measurement for payment will be made for the overlapping of fabric.

E. Ring Net

The quantity of Ring Net to be paid for will be the area in square yards, measured along the face of the Ring Net, over which the net has been acceptably placed. All hardware required shall be incidental to the cost of the Ring Nets.

5.0 BASIS OF PAYMENT

A. Rock Embankment Material

The quantity of Rock Embankment Material will be paid for at the contract unit price per ton for "Rock Embankment Material." Payment will be full compensation for all work and materials covered by this provision, including but not limited to furnishing, hauling, handling, placing, compacting, and maintaining the select material.

B. Select Material, Class VI

The quantity of select material will be paid for at the contract unit price per ton for "Select Material, Class VI." Payment will be full compensation for all work and materials covered by this provision, including but not limited to furnishing, hauling, handling, placing, compacting, and maintaining the select material.

C. Rip Rap, Class A

The quantity of Rip Rap, Class A will be paid for at the contract unit price per ton for "Rip Rap, Class A." Payment will be full compensation for all work and materials covered by this provision, including but not limited to furnishing, hauling, handling, placing, compacting and maintaining the select material.

D. Filter Fabric

The quantity of Filter Fabric will be paid for at the contract unit price per square yard of "Filter Fabric." Payment will be full compensation for all work covered by this provision, including but not limited to testing, furnishing, hauling, placing, and overlapping the filter fabric.

E. Ring Net

The quantity of Ring Net will be paid for at the contract unit price per square yard of "Ring Net." Payment will be full compensation for all work covered by this provision, including but not limited to testing, furnishing, hauling, placing, and connecting the ring nets. All hardware required shall be incidental to the cost of the Ring Nets.

Payment will be made under

Rock Embankment Material..... Tons
Select Material, Class VI..... Tons
Rip Rap, Class A..... Tons
Filter Fabric..... Square Yards
Ring Net..... Square Yards

TENSIONED ROCK BOLTS

1.0 DESCRIPTION

Furnish, install and test 1-1/4 inch diameter, 10 ft. minimum long steel bar rock anchors at locations as determined by the Engineer. The installation frequency, location and length of Rock Bolts are to be determined by the Engineer during construction of the Toe Scour Protection. Conditions encountered may require the Engineer to change the frequency and length of Rock Bolts from those indicated by these Special Provisions.

The Contractor is cautioned to the fact that the location of Rock Bolts may require the Contractor to work from cranes or other specialized methods.

Unless otherwise specified herein, install anchors according to the anchor manufacturer procedures and recommendations or as directed by the Engineer.

2.0 SUBMITTALS

Supply the following information:

A. Shop Drawings: Not less than 5 days prior to fabrication and include:

1-1/4 inch diameter rock anchor design details, including bond length, method of corrosion protection for permanent anchors, the head assembly, and reinforced concrete reaction block complete with doweling and reinforcing details. Detail drawings including specific method and procedure for drilling, installing, grouting and testing rock anchors.

B. Calibration Certificates: Not less than 5 days prior to commencing drilling and include:

Tensioning jack calibration certificate(s) of test which have been performed not more than 5 days prior to commencing drilling. Provide certificate showing the relationship between gauge pressure and applied load.

C. Product Data and Manufacturers Instructions: Not less than 5 days prior to commencing drilling and include:

1. Pre-mixed, non-shrink anchoring grout type.

2. Anti-corrosion compound for inside of anchor head.

3. Mill test reported for each heat or lot of prestressing components used to fabricate the anchors showing ultimate load, yield, percent elongation at yield and modulus of elasticity.

D. Daily Records: Within 5 days after completion of each anchor installation in each area. Submit records of each rock anchor on the Contractors anchor report form and test log. Include drilling conditions, bolt location, length, and grout volume.

3.0 MATERIALS

A. 1-1/4 Inch Diameter Rock Anchors

1. General: Use anchor assembly 1-1/4 inch diameter, 20 ft. long Grade 60 ksi deformed or continuously threaded steel bar conforming to ASTM 615 complete with corrosion protection system for permanent installations, centralizers on 4 ft. centers in bond zone, couplings where required, grout tubes, and anchor head assembly consisting of reinforced concrete reaction block, anchor plate, hardened washers, nut, and steel cover. The anchor head assembly must be capable of developing 100 percent of the guaranteed minimum ultimate tensile strength of the bar without cracking or deformation. Do not exceed a bearing pressure on the reaction block concrete of 4000 psf.

2. Manufacturer: Use all prestressing components from the product of a manufacturer regularly engaged in the fabrication of permanent rock anchor systems. The fabrication procedure must be in strict accordance with the manufacturer details.

3. Assembly: Use anchor assembly consisting of a bond length to be determined by the Contractor, and a variable free stressing length to suit any changes to the hole lengths. The assembly must be accordance to the manufacturers approved details.

4. Corrosion Protection: Include a corrosion protection system for the permanent rock anchor to protect the full length of the bar. The corrosion protection system should comprise a continuous plastic sheath grouted on to the bar, or and approved equivalent system. Apply corrosion protection system to the bars prior to their installation in the drill holes. Protect anchor head and the exposed bar under the anchor plate against corrosion, including an arrangement for pumping an anti-corrosion compound under the reaction plate to form a continuous seal of the unprotected portion of the bar.

   Paint the exposed anchor plate and bar with two coats of zinc-rich paint; the zinc-rich paint must meet the requirements of Article 1080-9 of the Standard Specifications.

B. Anchoring Grout

1. The grout must be a pre-mixed, unsanded, non-metallic, non-shrink grout, which can be mixed to a flowable consistency with a minimum 7-day compressive strength of 3000 psi. and a minimum 28 day compressive strength of 5500 psi. Cylinders will be made at such frequencies as determined by the Engineer and conduct testing in accordance to Section 1054-6 of the Standard Specifications.

2. Use pre-mixed grout from the product of a manufacturer regularly engaged in the manufacture of cementitious grouts for rock anchoring.

   a. Water

   Use water in Portland cement grouts that is clear, fresh water, free from injurious amounts of oil, acid, alkali, organic matter, sediment or any other deleterious substance.

   b. Reinforced Concrete Reaction Blocks

   Reinforced concrete reaction blocks, where required, to level or wedge the ground surface must be adequately reinforced to withstand the pressure of the reaction plate. All materials must meet the requirements for incidental concrete in Section 825 of the Standard Specifications.

3.0 CONSTRUCTION METHODS

A. General

Prior to installation, all anchor corrosion protection components and the anchor assembly must be handled and stored to avoid corrosion and damage such as abrasion, cuts, cracks, nicks, pits, welds or weld splatters. Furthermore, once the corrosion protection sheath has been grouted, use special handling procedures to prevent bending of the bar that could crack the grout in the sheath. Any such damage of the anchor components of the anchor assembly may be rejected as determined by the Engineer.

B. Installation Sequence

Sequence rock anchor installation and blasting operations such that no blasting is carried out within a distance of 200 feet from any bolt until the grout anchorage has set for a time not less than six days.

C. Site Preparation

Before drilling anchor holes, level all soil and loose and broken rock in the bearing area.

D. Drilling

1. General:

   a. Equipment: Drill holes with a rotary-percussion drill.

   b. Drill Logs: Driller must keep an accurate log noting depth from surface of any changes in rock hardness, rate of drilling, presence of water, fracture zones and voids.

   c. Cleaning: Clean holes thoroughly of all cuttings and rock fragments by flushing with high pressure air.

   d. Sequence: Drilling must precede reaction block construction.

2. Anchor Holes:

   a. Dimensions: Drill anchor holes a minimum diameter of 4 inch or as specified by the anchor manufacturer and 2 feet deeper than the anchor length.

   b. Orientation: Drill anchor holes no more than 30 degrees from vertical.

   c. Deviation: The anchor holes must not deviate by more than one foot from the specified location determined by the collar location and the required alignment of the anchor. The Engineer may require that drill hole orientation surveys be carried out, at the Contractors expense, where there is evidence of excessive deviation.

E. Water Test

1. Test Procedure: After cleaning the hole, fill drill hole with water, and the flow of water into the rock surrounding the hole must be observed for a period of 5 minutes.

2. Acceptance Criteria: The flow of water must not exceed 0.001 gals/inch diameter/foot depth/minute.

3. Grout and Re-drill: If the water flow exceeds the acceptance criteria, grout the hole with a cementitious sealing grout. Within 24 hours after grouting, re-drill and re-test the hole. Perform the grouting and re-drilling procedure until the

hole has passed the acceptance criteria. Conduct procedure at the Contractors expense.

F. Anchor Insertion:

1. Following acceptance of a drill hole, install the rock anchor assembly comprising steel bar, corrosion protection, centralizers and grout tubes in the hole. Do not bend anchors during handling and anchor must slide freely into the hole without hammering or pushing.

2. The anchor head assembly must be firmly supported at its final location during grouting and for the curing period.

G. Grouting

1. General: Place grout only at the temperature range recommended by the grout manufacturer.

   Do not use grout with an expired date in the work and dispose of at an authorized location.

   Do not use grout that has any hardened lumps in the work and dispose of at an authorized location.

2. Mixing: Mix grout in a colloidal or high shear grout mixer in accordance with the grout manufacturers published instructions. Use only enough mixing water to produce a grout with the required consistency for the placing method proposed. Place grout immediately after mixing.

3. Placing Grout:

   a. General: Place grout quickly and continuously to avoid overworking, segregation, bleeding and disturbance of initial set.

      Do not use grout which has stiffened due to delay in the work and dispose of at an authorized location.

      Do not re-temper grout after initial mixing.

   b. Pump grout into the annular space between the rock and the anchor using a grout tube extending to the lower end of the drill hole to fill the hole to the collar.

H. Concrete Reaction Blocks

1. General: Construct a concrete reaction block or a suitable quick set mix approved by the Engineer at each anchor location, where the ground has inadequate bearing capacity to support the load under the reaction plate, or where the ground surface is irregular or is not aligned at right angles to the axis of the anchor. The reaction block must form a uniform bearing surface for the steel reaction plate such that the bearing plate is aligned at right angles to the anchor, with its center coincident with the axis of the bar assembly.

2. Surface Preparation: Prior to pouring concrete on the ground surface, level surface with air/water jets and stiff brooming.

3. Anchor Block Construction: The concrete reaction block or quick set mix must be sized and reinforced as necessary to provide a bearing surface that can sustain the applied stress under the reaction block without bending or cracking.

I. Testing

1. Setting Time: The grout in the bond zone and concrete in the reaction block must meet the strength specified by the anchor manufacturer prior to testing the anchors.

2. Notification: Notify the Engineer notification of testing 48 hours prior to commencing testing.

3. Testing Equipment: Supply all testing, measuring and ancillary equipment.

4. Test Procedure: Set up a stable system to support the dial gauge used to make absolute measurements of the deflection of the head of the anchor. The system must be acceptable to the Engineer who will record and process all load/deflection measurements.

5. Hydraulic Jack: Tension all anchors using a calibrated hydraulic jack as specified by the anchor manufacturer.

6. Test Loads: Tension the anchors to the following loads:

Alignment Load (AL)	-	10 kips
Test Load (1.25P)	-	75 kips
Transfer Load (P)	-	60 kips

7. Performance Tests: Conduct performance tests on the first three (3) anchors in each Area, and up to thirty (30) other anchors in the project as selected by the Engineer. The Performance Test consists of a cyclic loading program according to the following procedure, with deflection of the head measured

relative to a stable reference point to an accuracy of .001 inch at each load interval:

i. AL, 0.25P, AL,
ii. 0.25P, 0.5P, AL,
iii. 0.25P, 0.5P, 0.75P, AL,
iv. 0.25P, 0.5P, 0.75P, 1.0P, AL,
v. 0.25P, 0.5P, 0.75P, 1.0P, 1.25P
vi. Hold for Creep Test
vii. Lock off at 1.0P

8. Proof Test: Proof test all anchors not performance tested according to the following procedure, with deflection of the head measured relative to a stable reference point to an accuracy of 0.001 inch at each load interval:

i. AL, 0.25P, 0.5P, 0.75P, 1.0P, 1.25P,
ii. Hold for Creep Test,
iii. Lock off at 1.0P.

9. Creep Test: At the Test Load on each anchor, perform a creep test by holding the load constant and recording the deflection of the head at the following time intervals:

i. 0, 0.5, 2, 5, 10, 30, 50 minutes for Performance Test,
ii. 0, 0.5, 2, 5 minutes for Proof Test.

10. Lift-off Test: After locking off the anchor at the Transfer Load, re-apply the load to determine the lift-off load. The lift-off load is the load at which the head of the anchor just starts to move as the load is applied.

J. Acceptance Criteria

1. Criteria: Accept an anchor if the following criteria are met:

The total elastic movement at the anchor head must be more than 80% of the theoretical elastic elongation of the free stressing length, and less than 100% of the theoretical elastic elongation of the free stressing length plus 50% of the bond length.

The creep movement at the anchor head does not exceed 0.08 inch during the Creep Test.

The lift-off load is within 10% of the Transfer Load.

2. Anchor Failure: If any anchor fails to meet the acceptance criteria, the Contractor, at his expense, must perform all of the following:

   a. Re-test the failed anchor using Performance Test procedures to as high a load as possible and determine the maximum load that will satisfy acceptance criteria I, II and III. Install an additional anchor in accordance with this specification at a location selected by the Engineer. The two anchors combined tension must not be less than 100 percent of the Test Load (P).

   b. Submit any method for improving the capacity of the anchor and obtain the Engineers authorization to proceed.

   c. For each failed anchor, test or re-test using Performance Test procedures, one additional anchor as selected by the Engineer.

5.0 METHOD OF MEASUREMENT

The quantity of 1¼ inch diameter rock bolts to be paid for will be measured by the linear feet from the lower end of the bar to the upper surface of the anchor plate to the nearest foot.

6.0 BASIS OF PAYMENT

The quantity of Tensioned Rock Bolts, measured as provided above will be paid for at the contract unit price per linear foot for Tensioned Rock Bolts.

Such price and payment will be considered full compensation for all work covered by this provision including but not limited to furnishing all materials, drilling, tensioning, testing, alignment measurements, grouting/redrilling as required, anchor grouting, and meeting all acceptance criteria of the anchors, as well as construction of the reaction blocks and removal of all formwork.

Payment will be made under:

Tensioned Rock Bolt.....Linear Feet